

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 09-162434
 (43)Date of publication of application : 20.06.1997

(51)Int.Cl. H01L 31/042
 H01L 31/04

(21)Application number : 07-316344
 (22)Date of filing : 05.12.1995

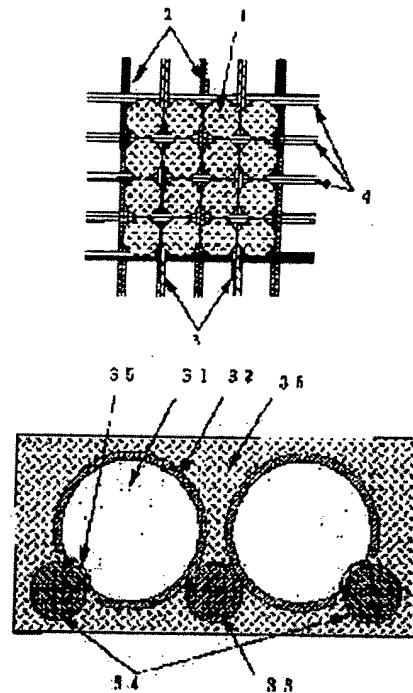
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(54) SOLAR BATTERY AND ITS MANUFACTURE

(57)Abstract:

PROBLEM TO BE SOLVED: To take out the output of a semiconductor lump through the first and second metal by arranging the first and second fiber glass bundles which hold the first and second metals in ohm contact with the p-type region and n-type region of a semiconductor lump, and bringing the first and second metals into contact with at least one place.

SOLUTION: Granular silicon 31 which constitutes a cell is made p type, and an n-type layer 32 is provided on the surface. Quartz glass fibers are made into a seven-twined warp 7. Seven quartz glass fibers coated with Ti and further thereon overcoated with Ag are twined into a first woof 2, and seven quartz glass fibers coated with Al and further overcoated with Ag are twined into a second woof 3, and they are woven like plain cloth. A cell is connected, at least at one place, to each of a conductor of both polarity being retained to be buried in a structure like a stitch. Plural cells are connected in parallel with each conductor, and the synthetic output of the cells connected in parallel can be taken out through the first and second metals.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

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CLAIMS

[Claim(s)]

[Claim 1] The 1st fiber glass bundle which supports the 1st metal which carries out ohmic contact to a semi-conductor lump's p mold field, It dissociates by turns and the 2nd fiber glass bundle which supports the 2nd metal which carries out ohmic contact to a semi-conductor lump's n mold field is arranged. The above-mentioned semi-conductor lump's p field The 1st metal of the fiber glass bundle of the above 1st, Moreover, this semi-conductor lump's n field is a solar battery characterized by contacting the 2nd metal of the fiber glass bundle of the above 2nd by at least one place, respectively, and taking out this semi-conductor lump's photo-electric-translation output through the 1st and 2nd metals supported by the above 1st and the 2nd fiber glass bundle.

[Claim 2] The metal supported by the 1st or 2nd fiber glass bundle is a solar battery according to claim 1 characterized by contacting two or more semi-conductor lumps in the same conductivity-type field of a semi-conductor, respectively.

[Claim 3] A fiber glass bundle is a solar battery according to claim 1 characterized by being formed by bundling the 1st or 2nd at least one or more metal wires and glass lines, twisting, or knitting.

[Claim 4] A fiber glass bundle is a solar battery according to claim 1 characterized by being formed by bundling the glass line containing the glass line with which the 1st or 2nd metal wire was covered, twisting, or knitting.

[Claim 5] the alloy which the 1st metal is III group element simple substances, such as aluminum, Ga, and In, or contains these elements at least -- or the silicon solar cell according to claim 1 characterized by being the complex of these simple substances or alloys, and the metal which bears conductivity, such as Cu and Ag.

[Claim 6] the metal with which the 2nd metal bears conductivity, such as aluminum, Cu, and Ag, and the alloy which contains V group elements, such as P, As, and Sb, at least in the part -- or the silicon solar cell according to claim 1 characterized by being the complex of these metals and alloys.

[Claim 7] The 1st and 2nd fiber glass bundles are solar batteries according to claim 1 characterized by a separation insulation being mutually carried out by the 3rd fiber glass bundle which does not support the metal which intersects these.

[Claim 8] The 1st and 2nd fiber glass bundles are faced that a separation insulation is carried out by the 3rd fiber glass bundle. The 1st and 2nd fiber glass bundles arranged by turns at parallel are made into the weft. The solar battery according to claim 7 characterized by presenting the shape of a volume on cage with two or more 3rd fiber glass which presents the shape of plain weave formed as warp which intersects the 3rd fiber glass bundle perpendicularly with this, or intersects the 1st and 2nd fiber glass at 60 degrees mutually.

[Claim 9] A semi-conductor lump is a solar battery according to claim 8 characterized by making the metal which is arranged in the opening which has the periphery section constituted by the 1st, 2nd, and 3rd fiber glass bundles, and is supported by the 1st and 2nd fiber glass, and electrical installation.

[Claim 10] The 2nd metal which connects in common the 1st metal supported by the 1st fiber glass bundle with the 1st lead wire which intersects perpendicularly with this, and is supported by the 2nd fiber glass bundle is a solar battery according to claim 9 characterized by connecting in common with the 2nd lead wire which intersects perpendicularly with this, and taking out the output of a solar battery through these 1st and 2nd lead wire.

[Claim 11] The 1st and 2nd lead wire is solar batteries according to claim 10 characterized by coming to connect by the opposite end mutually [the fiber glass lattice group which supported the metal, respectively].

[Claim 12] The solar battery according to claim 9 characterized by connecting a half-conductive mass group to a serial per fiber glass bundle by connecting by turns the fiber glass bundle which supported the

1st and 2nd metals which adjoin each other mutually at both ends.

[Claim 13] Two or more fiber glass bundles which supported the 1st metal, and some lead wire cross at right angles, and it is connected. By other parts of this lead wire making a unit structure which it comes to connect by intersecting perpendicularly with two or more fiber glass bundles which supported the 2nd metal, and repeating this structure by turns at the ends of a fiber glass lattice group The solar battery according to claim 10 characterized by obtaining the series connection which made the unit the half-conductive mass group held at two or more fiber glass bundles.

[Claim 14] The solar cell module which uses a solar battery according to claim 9 as the component.

[Claim 15] The solar cell module according to claim 14 by which it is coming-further-to lay under the transparency structure semi-conductor lump held by fiber glass bundle and fiber glass bundle characterized.

[Claim 16] The transparency structure is a solar cell module according to claim 15 characterized by being organic resin, such as inorganic materials, such as glass, or carbonate resin, acrylic resin, styrene resin, propylene resin, ethylene resin, vinyl resin, and fluororesin, or these laminating complex.

[Claim 17] The solar cell module according to claim 16 which carries out embossing and is characterized by the shape of a corrugated plate, and giving rigidity including a fiber glass bundle for a part of transparency structure [at least].

[Claim 18] The solar cell module according to claim 16 characterized by performing processing which does not support the 1st and 2nd metals in a fiber glass bundle in the breakthrough installation schedule part prepared in a part of transparency structure, and its boundary region.

[Claim 19] The electric apparatus using a solar cell module according to claim 16 as a generation-of-electrical-energy component.

[Claim 20] The 1st and 2nd fiber glass bundles which supported the metal Face that a separation insulation is carried out by the 3rd fiber glass bundle, and the 1st and 2nd fiber glass bundles arranged by turns at parallel are made into the weft. The glass fiber cloth characterized by presenting the shape of a volume on cage with two or more 3rd fiber glass which presents the shape of plain weave formed as warp which intersects the 3rd fiber glass bundle perpendicularly with this, or intersects the 1st and 2nd fiber glass at 60 degrees mutually.

[Claim 21] The manufacture approach of the solar battery characterized by including each process of the same semi-conductor lump's p mold field, and n mold field electrically connected by at least one or more places in each of the 1st [which the separation insulation was carried out by the 3rd fiber glass bundle, and supported the metal], and 2nd fiber glass bundles.

[Claim 22] The fiber glass fabric which consists of the 1st and 2nd fiber glass bundles in which the separation insulation was carried out by the process which diffuses an impurity on a semi-conductor lump's front face, and the 3rd fiber glass bundle and, which supported the metal is supplied. The process which makes the above-mentioned semi-conductor lump which did impurity diffusion adhere to this fiber glass fabric one layer of abbreviation by installation or attraction, The process which connects electrically p mold field and n mold field of a metal and the above-mentioned semi-conductor lump which were supported by the above 1st and the 2nd fiber glass bundle, respectively, The manufacture approach of the solar battery characterized by including this semi-conductor lump and the process which lays a fiber glass fabric underground at the process which performs electrical isolation of this semi-conductor lump's p mold field, and n mold field, and the transparency structure.

[Claim 23] The manufacture approach of a solar battery that the process according to claim 22 has been arranged along with the continuous fiber glass fabric.

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[Claim 18] The solar cell module according to claim 16 characterized by performing processing which does not support the 1st and 2nd metals in a fiber glass bundle in the breakthrough installation schedule part prepared in a part of transparency structure, and its boundary region.

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[Claim 22] The fiber glass fabric which consists of the 1st and 2nd fiber glass bundles in which the separation insulation was carried out by the process which diffuses an impurity on a semi-conductor lump's front face, and the 3rd fiber glass bundle and, which supported the metal is supplied. The process which makes the above-mentioned semi-conductor lump which did impurity diffusion adhere to this fiber glass fabric one layer of abbreviation by installation or attraction, The process which connects electrically p mold field and n mold field of a metal and the above-mentioned semi-conductor lump which were supported by the above 1st and the 2nd fiber glass bundle, respectively, The manufacture approach of the solar battery characterized by including this semi-conductor lump and the process which lays a fiber glass fabric underground at the process which performs electrical isolation of this semi-conductor lump's p mold field, and n mold field, and the transparency structure.

[Claim 23] The manufacture approach of a solar battery that the process according to claim 22 has been arranged along with the continuous fiber glass fabric.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the configuration and its manufacture approach of a solar battery and a solar cell module. It is related also with a noncommercial smallness power generation of electrical energy in more detail at the suitable manufacture approach for mass production method, concerning the configuration of the suitable cheap and lightweight high performance solar battery also for the generation of electrical energy for power.

[0002]

[Description of the Prior Art] The well-known crystal silicon solar cell with which practical use is presented conventionally consists of silicon substrates 11 of the single crystal in which thickness has the magnitude of 100mm angle thru/or 150mm angle by 250 microns thru/or about 350 microns, or polycrystal, as shown in drawing 2. This silicon substrate usually has the conduction type of p mold, the diffusion layer of **** is prepared in the single-sided principal plane used as a light-receiving side, the fishbone's electrode 13 is respectively formed in n type layer 12, nothing, a light-receiving side, and a rear face, and a solar battery element is constituted. An electrode (14) on the back may be formed in the whole surface so that it may illustrate. As shown in drawing 3, a resin seal is carried out and a module is constituted so that it may insert with the face shield and the moisture-proof film 18 of tempered glass 17, as this solar battery element 15 is shown in drawing 4, while an electric insulation prepares a clearance required to be made, arranges in all directions and connecting with a serial through the connection lead 16. In order to obtain the power of 100 thru/or 220V by conversion into ac, while connecting this module to the serial further and obtaining the request electrical potential difference, by having made into the unit the module group by which the series connection was carried out, parallel connection of the module group was carried out so that a necessary current might be acquired, and the solar-battery array was constituted.

[0003] Conventionally [these], although the solar battery of structure is in a mature phase technically, from a viewpoint of power cost, it is hard to be referred to as that the cost of a solar battery element or a module is fully reduced, and has come to spread widely as an object for general power. In order to reduce solar-battery cost, devices various until now are made. For example, in the process which forms a substrate, in order to skip cutting of an ingot, and the process of a slice, the attempt orthopedically operated in the shape of a direct sheet from melt was made. However, problems, such as control of the grain boundary, residual distortion, and impurity mixing from a plastic surgery fixture, are not solved, it is dissatisfied on a property or many cannot serve as the technique in which there is much constraint on a production process and it excels cutting of an ingot, and a slice.

[0004] On the other hand, some proposals are made also about the manufacture approach of a solar battery of not using the substrate of a sheet condition until now, and approaches, such as making the approach using the microcrystal silicon obtained by gaseous-phase reduction granulation which is indicated by JP,51-27077,A, and the insulating material substrate which has a metallic film so that it may be indicated at JP,51-129129,A carry out heating joining of the silicon fine particles etc., are in a solar battery element. Since particle size is too small, practical use has come to be presented with these. Although indicated by JP,3-76273,A or JP,6-13633,A about the solar battery using spherical silicon with a still bigger particle size, it has succeeded in realizing a certain amount of component engine performance so that it may be indicated by the page 1045 of the 22nd IEEE photovoltaics expert meeting minutes thru/or 1048 pages (Conference record of the 22 nd IEEE Photovoltaic Specialists Conference (1991) and pp.1045-1048.) about the latter.

[0005] The latter structure is having structure which embedded the silicon ball 21 whose diameter is a little less than 1mm at aluminium foil 22, as shown in drawing 5. A silicon ball is p mold, the surface layer 23 is

diffused in n mold, and connection of a negative electrode is taken by pressing this fit in aluminum foil 22. Connection of a positive electrode ground the end for a non-light sensing portion of the above-mentioned silicon ball, exposed p field, and is realized by making the aluminum foil for the above-mentioned negative electrodes, and the aluminum foil 25 of one more sheet formed through the insulator layer 24 contact. Although such structure is rich in flexibility and the path is paved for continuation formation, the process which embeds a detailed silicon ball at aluminum foil was complicated, and there was a difficulty in manufacturing to a high speed and a large quantity.

[0006]

[Problem(s) to be Solved by the Invention] By offering the new maintenance approach of a granular silicon cel, this invention enables continuous manufacture at high speed, and it is cheap and it aims at offering the solar cell module which was rich in application, and its production system.

[0007]

[Means for Solving the Problem] The above-mentioned technical problem improves substantially by holding the granular silicon which constitutes a solar battery element by the structure of the mesh who has arranged by turns the conductor of the amphipathy by which insulating separation was carried out mutually, as shown in the conceptual diagram of drawing 1.

[0008] The situation that the solar battery element (a cel is called below) is held is shown in drawing 6 in cross section. The granular silicon 31 which constitutes a cel is p mold, and n type layer 32 is formed in the front face. A cel is held so that it may be embedded at the mesh Mr. structure, and it is connected to each of the conductor of the amphipathy established there by at least one place. Usually, the conductor 33 connected to n type layer of a cel makes Ag a subject, the conductor 34 connected to p mold field of a cel makes Ag containing aluminum a subject, and p mold field and non-rectifying action connection are made by alloying in the connection 35 with granular silicon. the surface n type layer of a periphery is removed in a part for the connection to this p mold field -- having -- **** -- the connection with p mold field -- the connection with a conductor (the following and a positive electrode -- a conductor is called) and a surface n type layer -- electrical isolation with a conductor (the following and a negative electrode -- a conductor is called) is realized. each -- two or more cels are connected to the conductor at juxtaposition, and when light hits, the comprehensive output of a cel by which parallel connection was carried out is obtained from a conductor. a positive electrode -- a conductor 34 and a negative electrode -- the conductor 33 is arranged by turns and the output characteristics of the solar battery which constituted positive electrodes and negative electrodes by connecting with juxtaposition using the conventional plate mold substrate, and resemblance are obtained. moreover, forming the situation that single-tier formation of the cel is not carried out, or having left the conductor of a couple to the connectionless condition -- a positive electrode -- a conductor and a negative electrode -- it also becomes possible by connecting a conductor to a serial to take out the output of high tension. Therefore, it becomes possible to constitute the module of a desired unit at a stretch by preparing the mesh Mr. structure which prepared wiring of a serial parallel beforehand.

[0009] Since the structure which supports a cel is the mesh who has the opening which cannot pass a cel, it is drawing in compulsorily etc., and even if it does not treat a cel separately, a grain-like cel can be easily arranged in self align, it is making heating alloying perform simultaneously, and very high productivity is acquired. Although the cel supported by the mesh Mr. structure is weak against an impact if it remains as it is, carrying out a lamination with a resin film, or operating orthopedically, by carrying out a resin seal, rigidity can be given and it can form in a weatherproof **** module. These processes can be performed on continuation or a continuation target, realizing high productivity.

[0010]

[Embodiment of the Invention] Hereafter, this invention is explained in accordance with an example.

[0011] (Example 1) A cel is formed from granular silicon of 0.5-2ohms of p molds cm. The manufacture approach of granular silicon is outside the object of this invention, and does not make reference here. Although it is not cared about even if granular silicon is polycrystal, and it has single-crystal-ized it again, as for near and particle size, for applying this invention, it is desirable for a configuration to be [for the diffusion length of a minority carrier] more than particle size in 300 thru/or about 500 micrometers at an outline globular form. In this example, Czochralski crystal of 0.5ohms of p molds cm was cut down on 0.7mm square, and it is the mixture of fluoric acid and a nitric acid, and etched isotropic, and what was adjusted to the particle size of 500**50 micrometers was used.

[0012] n type layer was formed filling up with granular silicon the cylinder made from quartz glass which formed drawing in both sides, and making it rotate centering on a cylinder shaft. formation of n type layer -- nitrogen gas 0.5 l/min Oxygen gas 0.4 l/min a gaseous mixture -- POCl3 -- a bubble -- carrying out -- this and nitrogen gas 4 l/min the inside of the mixed ambient atmosphere -- 850 degrees C and 35min heat-treating -- after that and an ambient atmosphere -- oxygen gas 10 l/min changing -- further -- 5

min it carried out by heat-treating.

[0013] the inside of the desiccation oxygen gas ambient atmosphere after once removing the phosphorus glass formed in the front face of granular silicon by diluted fluoric acid and carrying out forcible washing by deionized water, and 800 degrees C and 60 min -- it oxidized. What was formed by this is the granular silicon cel 1 in drawing 1 .

[0014] On the other hand, the mesh Mr. structure (it is described as a glass fabric below) which supports a granular silicon cel was formed as follows. The basic structure is quartz glass fiber whose wire size is 25 micrometers, and used as warp (4 reference of drawing 1) what twisted seven of these. What twisted seven things which turned 0.1-micrometer coat of Ti to quartz glass fiber up, and carried out 2-micrometer coat of Ag was made into the 1st weft (3 reference of drawing 1). Moreover, what turned 0.1-micrometer coat of the aluminum to quartz glass fiber up, carried out 1.5-micrometer coat of Ag, and carried out 0.1-micrometer coat of Ag for aluminum 0.4 micrometers and on it further was made into the unit, and what twisted seven of these was made into the 2nd weft (2 reference of drawing 1). It wove to the flat cloth using these warp and 1st and 2nd weft. The pitch of yarn spacing is 0.5mm. The 1st weft was formed in the one direction of a flat cloth for a long time 10mm than the 2nd weft, and the 2nd weft was formed in the opposite direction of a flat cloth for a long time 10mm than the 1st weft. This is needed at the time of the ejection of a next photoelectrical output.

[0015] Immobilization of granular Si to a glass fabric used the revolution heating attraction drum unit as shown in drawing 7 . A glass fabric 41 is sent from a roll reservoir (not shown), it is twisted around the revolution attraction drum 42, and the glass fabric 48 with which the granular Si cel was fixed is sent to a reel (not shown). While the granular Si cel 43 is supplied to a rotating drum from the cel supply pipe 44, the glass fabric attracted by the revolution attraction drum is adsorbed. Although it is an ideal that each eye of a glass fabric is adsorbed in a granular Si cel, it does not interfere, even if there is a granular Si cel of the eye which remains without being able to adsorb actually, and the excess by which the gap of a granular Si cel where it adsorbed is adsorbed further. The granular Si cel of an excess is effectively removed by the blower 45, returns to a gutter 46, circulates further, and is supplied again. While the granular Si cel in which the eye of a glass fabric was adsorbed is heated on a fixed drum and being firmly pushed into a glass fabric eye, alloying takes place in part, and contact to the 1st weft and the surface n diffusion layer of a granular Si cel is acquired, and the non-rectifying contact according [the 2nd weft and p core of a granular Si cel] to aluminum alloying is formed. If forced oscillation, such as a supersonic wave, is desirably added at the time of this actuation, it is effective for acquiring firm and positive contact. As a result of this actuation, since it is canceled at subsequent processes even if it is in a short circuit condition, the 2nd weft and the surface n diffusion layer of a granular Si cel do not interfere. Whenever [stoving temperature / of the drum for immobilization] is 750 degrees C, and, as for the ambient temperature of the fixed process of a granular cel, it is effective to keep at 500 degrees C or more. In addition, drawing 7 is drawing showing the principle of a process, and is not what expressed the dimension of actual equipment faithfully.

[0016] In addition, it carries out to this process and coincidence by the approach of showing the connection for the parallel connection of granular Si in drawing 8 . Like the above-mentioned, from the weft of the others in the both sides of a glass fabric respectively, the weft is formed for a long time 10mm, and as it connects the weft of the same class, it connects an electrode lead. namely, a positive electrode -- the 2nd weft formed with a conductor 2 is connected mutually -- as -- the positive electrode lead 5 -- preparing -- a negative electrode -- the negative electrode lead 6 is established so that the 1st weft formed with a conductor 3 may be connected mutually. although there is especially no assignment in a connection method -- a tabular lead -- a lengthwise direction -- bending -- each -- the approach of sticking by pressure so that a conductor may be put was trustworthy. Although each electrode lead is used in the condition of having continued to serve both as the object for actuation or guide of a glass fabric, after separating into each submodule, as shown in drawing 8 , the end is respectively connected to terminal assemblies 7 and 8, and the output ejection to the exterior is presented with it, until a module is formed.

[0017] Although it returns to a process, being immersed in the cell with which the etching reagent was filled, and irradiating light, the glass fabric with which the granular Si cel was fixed is etched electrochemically, and performs a pn junction. The reason which irradiates light is for using the effectiveness that an etching reaction is accelerated in the exposed part of pn junction by work of a local battery. This processing is very effective in a short time, and each granular Si cel comes to commit it as an independent solar battery respectively through this process. Furthermore, to serve also as surface passivation, with the pyrolysis gaseous-phase vacuum deposition of the organometallic compound of Ti, 65nm of TiO₂ used as the antireflection film is formed, and modular basic structure is completed.

[0018] Some approaches are possible in order to carry out a modularization. In order to consider as

general module structure, the above-mentioned module basic structure is cut by suitable die length, the lamination of the whole is carried out across the table rear face of the above-mentioned basic structure with a bonnet, the consolidation white sheet glass of 4mm thickness, and aluminum lamination fluororesin film with a thickness of 125 micrometers with a still better known EVA film, and a terminal assembly is formed in an electrode lead, closing a periphery by installation and isobutylene isoprene rubber so that it may dedicate in a metal frame.

[0019] In the case of this invention, modular basic structure is a continuum and long module formation is possible for it, but all cells are not usually connected to juxtaposition and it is necessary practically by making magnitude of a certain extent into a unit to carry out a series connection. In the case of this invention, as shown in drawing 9 (A), the smallest unit of a cell is granular Si1, but the granular Si cell train connected in common by the 1st and 2nd weft is already mutually connected to juxtaposition, and the comprehensive output is taken out by the 1st and 2nd weft 2 and 3 extended to glass fabric both ends. The series connection of a granular Si cell column group of each leads 5 and 6 of the positive electrode which connects the weft, and a negative electrode becomes possible by dividing for every granular Si cell column group of suitable magnitude, and short-circuiting the negative-electrode lead 6 and the positive-electrode lead 5 in jumpering 9. Drawing expressed in the equal circuit using a diode notation is shown in drawing 9 (B). In the above-mentioned connection, since the output voltage of each granular Si cell train is about 0.5V, about 0.5 V is obtained also for the output voltage of a granular Si cell column group, and, as for the output current of a granular Si cell column group, the number twice of the output current of a granular Si cell are obtained. Therefore, near and the output current are equal to the value of a number of a granular Si cell column group of abbreviation 1/2 with which modular output voltage was connected to the serial to the output current of a unit granular Si cell column group. The module with a width of face [of 100mm] and a die length of 300mm was formed in 0.5mm pitch, the granular Si cell column group was constituted from an example for every die length of 25mm, and the meantime was connected to the serial. The open circuit voltage of the module in the optical exposure conditions of AM1.5 and 100 mW/cm² was 7.8V, the short-circuit current was 0.55A and conversion efficiency was 10.7%.

[0020] What is necessary is for the jumpering which connects between forward negative-electrode leads as shown by drawing 9 to become unnecessary, and just to prepare the lead 9 and 9' which only tie two granular Si cell column groups by designing the value of an electrical-potential-difference current beforehand, and pulling out the 1st and the 2nd weft by turns for every granular Si cell column group, as shown in drawing 10 when the magnitude of the granular Si cell column group made into a unit is decided. After this connects a granular Si cell train with the lead of ends, in order to realize it by cutting a lead according to a granular Si cell column group, productivity becomes good more. In addition, although it is necessary to remove the granular Si cell column group of one to 2 train in order to carry out a series connection, the loss for it is 2 - 4% in the above-mentioned example. By the module furthermore optimized, the mask of a part of glass fabric part is carried out to the part which carries out a series connection, and a granular Si cell train is made not to be formed in it. Or in case a glass fabric is formed, inserting as the weft the glass fiber with which metallic coating is not performed for every unit of the supposing the granular Si cell column group of a unit can also realize separation of a granular Si cell column group.

[0021] A modularization is performed by including in protection material or maintenance material, after the above-mentioned connection is performed, but lightweight-izing is possible by inserting into transparent plastics other than the above-mentioned glass super straight structure, such as polymethylmethacrylate and a polycarbonate, and carrying out lamination molding, and if a mould is carried out also to a front flesh side with the glass of a low-melt point point, weatherability and fire retardancy will be improved. Although the white sheet consolidation plate glass 4mm or more adopted by the conventional glass super straight method is needed in order to secure the reinforcement as a module, it becomes fully securable [self-hold thru/or need reinforcement] also with an about 2mm thin module object by embossing formation of a corrugated plate or a three dimension as shown in drawing 11 or drawing 12 .

[0022] Drawing 11 (A) is the conceptual diagram of the module processed in the shape of a corrugated plate. Some [the / 50] cross sections are shown in drawing 11 (B). Many granular Si cells 1 are fixed and a module is formed by unifying on both sides of the glass fabric 48 by which connection was carried out by the table lamination material 51 and the flesh-side lamination material 52. Various things are used for a lamination ingredient according to applications, such as acrylic resin (PMMA etc.), a polycarbonate, polyethylene system resin (PET etc.), and styrene resin. As a table lamination ingredient, spreading or the thing which carried out the laminating is also used for the glass material processed in the shape of a corrugated plate in the resin for a buffer of EVA etc. The laminated film of shock absorbing material, such as EVA, and fluororesin may be used as a flesh-side lamination ingredient. These lamination material may combine and use. Moreover, it is also desirable from a viewpoint of a deployment of light to carry out the

laminating of films, such as aluminum with a high reflection factor, or the thin film to a flesh side. As for the approach of utilization, it is also arbitrary to also use a corrugated plate-like module independently and to reinforce by the frame and to use. Although there is especially no limit in the curvature of a corrugated plate, the curvature in which bending of a fiber cloth is possible is min, and although max serves as magnitude which can give modular rigidity, it is the range of about 3-20mm in radius of curvature desirably.

[0023] Drawing 12 (A) is the conceptual diagram which expressed visually the example processed in the shape of three-dimension embossing, and is the example cast in the shape of [which is expressed by $Z = \sin X + \cos Y$ to a height Z direction about the location within a module side (X, Y)] a curved surface. The cross section in alignment with the X-axis or a Y-axis is a configuration as shown in drawing 11 (B), and can raise flexural strength to every direction. This module should just also prepare a reinforcement frame on the outskirts if needed. Although there is especially no limit in the configuration of embossing, and a dimension, the consideration which mitigates the stress concerning module basic structure is required, and its configuration which changes smoothly with the curvature of about 3-20mm succeeding the direction of X-Y is desirable like the case of the corrugated plate of drawing 11.

[0024] If the above-mentioned module structure is possible, it closes manufacture by the continuous process as shown in drawing 13. In addition, drawing 13 shows the configuration of a process typically and refuses beforehand that it is not faithful to a actual configuration.

[0025] A glass fabric as shown in drawing 13 (A) from the supply reel 61 is supplied. A glass fabric uses glass fiber as warp, it carries out a plain weave by the weft which allotted by turns the 1st weft which twisted glass and Ag coat line, and the 2nd weft which twisted glass and aluminum, and Ag coat line, and it is beforehand formed in the shape of a roll at another process.

[0026] A hopper is loaded with granular Si62 adjusted to the particle size of 0.5mm, and 1-2ohms of p molds cm, it is suitably supplied to the belt 63 for diffusion, and is sent to a diffusion furnace 64. It is heated in POCl_3 ambient atmosphere here, and n+ layer is formed in a front face. Granular Si by which n+ layer was formed in the front face is once stored in another hopper 65, and is supplied to the glass fabric sent from the supply reel 61. The condition that each eye of a glass fabric was loaded with granular Si by the blow controlled [which were controlled and was enforcement-attracted] as shown in drawing 13 (B) is made from this process. By passing through a heating furnace 66, where granular Si is temporarily fixed to a glass fabric, alloy fixing with the electrode metal and granular Si which were taught to the warp of a glass fabric takes place, and, as for the 1st weft, p nucleus part of granular Si and electric contact are acquired through p+ recrystallized layer in this phase, as for n+ mold surface layer and the 2nd weft. In this phase, the 2nd weft forms contact with an electric surface n+ layer, and the junction as a solar battery is not separated. Subsequently, the antireflection film of TiO_2 is formed in the CVD furnace 67 for this by oxidation of tetra-propoxy-titanate in delivery and atmospheric pressure. Under the present circumstances, although heterogeneity arises in thickness with the irregularity of a covering substrate and it is formed in the thickness of acid-resisting conditions on a front face, near the point of contact with a glass fabric, it hardly covers.

[0027] the etching tub 68 with which this was filled up into lye -- delivery and the thin granular Si part of the antireflection film -- **** -- it etches thinly. At this time, a part for the joint of p mold and n mold is early etched more by work of the local battery produced by optical exposure, and, thereby, junction isolation of pn is performed. That is, as shown in drawing 13 (C), the 2nd weft forms the field of p mold, and electric contact, and it becomes possible to take out the output of the positive/negative of a solar battery from each weft.

[0028] The glass fabric which ended junction isolation is cast by tabular module foundation structure as passed along a cleaning tank 69, impregnation carried out by the resin supplied from the organic resin feeder 70, and curing carried out with a heating furnace 71 and shown in drawing 13 (D), and is rolled round by the machine reel 72.

[0029] Just before carrying out curing with a heating furnace 71 for processing it a corrugated plate or in the shape of embossing, configuration molding is performed to the midst, and it is cut and accumulated by the die length suitable in this case for a volume and ****.

[0030] As compared with module formation of the conventional shape of a substrate Si, module formation is possible for this production process at a continuation part, and as long as there is no limit in the width of face of a glass fabric and equipment allows by adopting a granular cel, module formation is possible for it also by the width of face which is several m. Moreover, although it rolled round to the reel and the possibility of the continuation formation by batch processing of a roll two roll was shown by this example, consistent integration of all processes is also possible by continuation-izing from the formation process of glass fiber. Therefore, by application of this invention, the production process which was extremely rich in mass production nature can be built.

[0031] (Example 2) Drawing 14 is the perspective drawing which looked at the maintenance situation of a granular Si cel with a diameter [by the glass fabric which used the fiber with a diameter of 25 micrometers as 7 twist plain weave] of 500 micrometers from the weft. Although the pitch of a fiber is the same 500 micrometers as the diameter of the granular Si cel 1, the overall diameter of a fiber is 75 micrometers, and a granular Si cel is held by the glass fabric, without passing texture, even if there is a maximum of 75-micrometer particle-size fluctuation. the case where particle size is 500 micrometers -- a positive electrode -- a conductor 2 and a negative electrode -- the weft and the granular Si cel 1 by the conductor 3 touch in one fourth of the height of a diameter mostly, and two points of contact are obtained about each conductor at a time. The radius of curvature of glass fiber support can form a plain-weave-like glass fabric without those of a path with 30 times, and unreasonableness by about 750 micrometers. Increasing the number of stranded wires does not bar using glass fiber thinner than this. Although reinforcement becomes weak a little, it is effective in raising the yield of a poor contact that the number of points of contact with a granular Si cel increases. However, if many [too], a necessary metallic material will increase and it will become rather uneconomical.

[0032] Drawing 15 is the metallic conductor supported by glass fiber and drawing showing a contact situation with a granular Si cel. Coating of the 0.1-micrometer aluminum layer (in drawing, it does not show clearly) is carried out to fiber glass 81 on a front face, and the Ag layer 82 with a thickness of 1.5 micrometers and the aluminum layer 83 which is 0.5 micrometers in thickness further are formed in up [the]. A metal layer deforms into extent which touches fiber glass 81 in the phase where the granular Si cel 1 was held. aluminum layer near the point of contact and the surface layer of granular Si alloy at the process of alloy-izing, and p+ layer which is mostly equivalent to the thickness of aluminum layer is formed in Si nucleus side of an alloy layer 84. The output of a cel 1 is transmitted to a metal layer through this.

[0033] For the object which realizes contact to p mold field, the coat of the high conductivity metals which contain III group elements used here, such as Ga besides aluminum and In, in the form of a simple substance or an alloy, such as Ag and Cu, may be carried out to glass fiber, or a thin line may be twisted. In order to realize contact to n mold field similarly, under the controlled conditions besides Ag or the high conductivity metal of Cu, the activity of aluminum is also possible, and it is more effective in the former that V group elements, such as P, As, and Sb, are included.

[0034] Although twisting both glass fiber is also considered, as metaled single track is shown in drawing 14 as a fiber, the opportunities of contact to granular Si are few, and in order to make it contact certainly, it can be understood that the structure where the metal was supported by each glass fiber is desirable. moreover, the case of single track -- the process of alloy-izing -- alloying -- self -- a restrictive device does not work, but there are a danger of forming a deep alloy layer in granular Si, and danger of an open circuit of a metal wire, and the structure where the metal was supported by glass fiber is desirable too.

[0035] Drawing 16 shows other examples of this invention about maintenance of a granular Si cel. as the weft combined with the warp 4 which is what replaced with the glass fabric of the shape of a plain weave shown in drawing 1, and was formed in the shape of *****, and consists of glass fiber -- a positive electrode -- a conductor 2 and a negative electrode -- in addition to the 2nd and 1st weft which consists of conductors 3, 3rd weft 4' which consists of glass fiber is allotted. also in this case, a positive electrode -- a conductor 2 and a negative electrode -- a conductor 3 is arranged in parallel to alternation, and it has structure separated by the insulator so that it may not connect too hastily mutually. In this example, by arranging a spherical Si cel by minute restoration, the filling factor (projected area) of a cel becomes 91%, and can improve a filling factor about 15% compared with the case of a plain weave. In the case of a non-condensing module, this can become with an improvement of an output, and can raise module reinforcement. About the approach of the connection about the limitation of the die length about the ejection of a conductor, and the series connection of a submodule, it is applicable like the case of a plain weave.

[0036] (Example 3) When a generation of electrical energy is presented with the module formed with the application of this invention, it can consider as the module excellent in workability with devising connection beforehand. Drawing 17 (A) has illustrated the situation in the case of forming a roof for many corrugated plate-like modules in piles. Although the example which fixed the corrugated plate module 91 of two sheets to sarking 92 in piles is shown here, the cross section of the situation is shown in drawing 17 (B). Although the fixed portion 93 pierced through the module of two sheets and has concluded it with the bolt, for making this possible, it is necessary to form a breakthrough 94 in a module. Although a submodule generally is not arranged around a breakthrough 94, when a module is linearly formed like the manufacture example of this invention in that case, a big useless area equivalent to the width of face of the submodule of a unit will be produced. Then, even when the field 96 which does not support a metal beforehand is established in a part of glass fiber group 97 which supported the metal about the part of that schedule

area 96 when the location in which a breakthrough 95 is formed like drawing 17 (C) was able to assume beforehand and a granular Si cel is temporarily fixed to this part, it is advantageous on a process to fix positively the poor opening condition which does not contribute to a generation of electrical energy. A module can be manufactured that what is necessary is just to carry out the plain weave of the glass fabric at the same process as usual between the glass fiber groups 98 used as warp, without barring other production processes. When it becomes the schedule field processible [which digs a breakthrough mechanically] and a module can be more simply formed in it after a modularization is carried out if it does in this way, construction becomes easy, therefore solar-battery array cost can be reduced.

[0037] (Example 4) Other examples of this invention are shown in drawing 18 . a positive electrode -- a conductor 2 and a negative electrode -- a conductor 3 is made into the weft and a granular Si cel serves as reverse juxtaposition in the direction of warp in the glass fabric of the plain weave which has arranged this by turns. the positive electrode which adjoins each other mutually at the edge of the weft here if the granular Si cel 1 can be located in a line every other train like drawing 18 (A) -- a conductor 2 and a negative electrode -- a series connection becomes possible by making a granular Si cel train into a unit by connecting a conductor 3. The equal circuit is shown in drawing 18 (B). A number of a granular Si cel train of more than electrical potential differences of V which are equivalent to 2 about 1/by which the series connection was carried out are obtained from output terminals 7 and 8. In the case of the module which consists of glass fabrics of granular Si with a diameter of 500 micrometers and 500-micrometer pitch, the output of 100V will be obtained every 10cm. the positive electrode which uses glass fiber 4 as warp and serves as the weft as it is shown in drawing 18 (C), in order to put a granular Si cel train in order every other train -- a conductor -- the weft 2 and a negative electrode -- a conductor -- the weft 3 -- in addition -- for example, what is necessary is just to interfere so that granular Si cel 1' may not be fixed by the 3rd weft 400 which consists of glass fiber Such a configuration is possible by the well-known textile-fabrics method.

[0038] (Example 5) Other examples of this invention are shown in drawing 19 . This is an example which made it the number of the eyes of the glass fabric of a plain weave, and has arranged the granular Si cel every every direction 2 eye. This is an example by which granular Si cel 1' has been arranged at the core of a 9 times as many field as own magnitude. this -- the three weft of a plain weave -- a unit -- carrying out -- a positive electrode -- a conductor 2 and a negative electrode -- it is arranged, and obstructive yarn 400 is inserted in the train in which a granular Si train is not formed in addition by 2 continuation, and it is formed so that each warp of a conductor 3 and a nonconductor 200 may be repeated. Moreover, obstructive yarn 401 is formed in 2 continuation about the nonconductor yarn 4 which forms a plain weave also about warp, and the train to which a granular Si cel is not fixed. Such a configuration is also easily possible with a well-known textile-fabrics technique. The solar cell module with which the granular Si cel has been arranged by the production process shown in the example 1 when preparing such a glass fabric so that it may illustrate can be formed. By applying to the module which equipped each granular Si cel with the condenser lens, such a configuration can reduce the amount of the semi-conductor used in the same light-receiving area a figure single [about], using the same process, and can offer the solar battery of low cost.

[0039]

[Effect of the Invention] According to this invention, the solar battery of comparatively high conversion efficiency can be continuously manufactured at a high speed using a cheap silicon ingredient. If it is the base constituted with a fiber if the meaning of this invention is followed, it will not be restricted to the configuration or its arrangement of yarn, and a textile-fabrics method.

[0040] Moreover, although the example has described the structure and the manufacture approach of a solar battery about the body of a solar battery based on the semi-conductor lump of p mold, it cannot be overemphasized by replacing the polarity of a conduction type also about a n-type-semiconductor lump that it can carry out similarly. Moreover, even if semi-conductors are the element semiconductor not only containing Si but germanium etc., a group III-V semiconductor, an II-VI group compound semiconductor, KARUKO pyrite compounds, or these conjugated compounds, they do not interfere.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the configuration and its manufacture approach of a solar battery and a solar cell module. It is related also with a noncommercial smallness power generation of electrical energy in more detail at the suitable manufacture approach for mass production method, concerning the configuration of the suitable cheap and lightweight high performance solar battery also for the generation of electrical energy for power.

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PRIOR ART

[Description of the Prior Art] The well-known crystal silicon solar cell with which practical use is presented conventionally consists of silicon substrates 11 of the single crystal in which thickness has the magnitude of 100mm angle thru/or 150mm angle by 250 microns thru/or about 350 microns, or polycrystal, as shown in drawing 2. This silicon substrate usually has the conduction type of p mold, the diffusion layer of **** is prepared in the single-sided principal plane used as a light-receiving side, the fishbone's electrode 13 is respectively formed in n type layer 12, nothing, a light-receiving side, and a rear face, and a solar battery element is constituted. An electrode (14) on the back may be formed in the whole surface so that it may illustrate. As shown in drawing 3, a resin seal is carried out and a module is constituted so that it may insert with the face shield and the moisture-proof film 18 of tempered glass 17, as this solar battery element 15 is shown in drawing 4, while an electric insulation prepares a clearance required to be made, arranges in all directions and connecting with a serial through the connection lead 16. In order to obtain the power of 100 thru/or 220V by conversion into ac, while connecting this module to the serial further and obtaining the request electrical potential difference, by having made into the unit the module group by which the series connection was carried out, parallel connection of the module group was carried out so that a necessary current might be acquired, and the solar-battery array was constituted.

[0003] Conventionally [these], although the solar battery of structure is in a mature phase technically, from a viewpoint of power cost, it is hard to be referred to as that the cost of a solar battery element or a module is fully reduced, and has come to spread widely as an object for general power. In order to reduce solar-battery cost, devices various until now are made. For example, in the process which forms a substrate, in order to skip cutting of an ingot, and the process of a slice, the attempt orthopedically operated in the shape of a direct sheet from melt was made. However, problems, such as control of the grain boundary, residual distortion, and impurity mixing from a plastic surgery fixture, are not solved, it is dissatisfied on a property or many cannot serve as the technique in which there is much constraint on a production process and it excels cutting of an ingot, and a slice.

[0004] On the other hand, some proposals are made also about the manufacture approach of a solar battery of not using the substrate of a sheet condition until now, and approaches, such as making the approach using the microcrystal silicon obtained by gaseous-phase reduction granulation which is indicated by JP,51-27077,A, and the insulating material substrate which has a metallic film so that it may be indicated at JP,51-129129,A carry out heating joining of the silicon fine particles etc., are in a solar battery element. Since particle size is too small, practical use has come to be presented with these. Although indicated by JP,3-76273,A or JP,6-13633,A about the solar battery using spherical silicon with a still bigger particle size, it has succeeded in realizing a certain amount of component engine performance so that it may be indicated by the page 1045 of the 22nd IEEE photovoltaics expert meeting minutes thru/or 1048 pages (Conference record of the 22 nd IEEE Photovoltaic Specialists Conference (1991) and pp.1045-1048.) about the latter.

[0005] The latter structure is having structure which embedded the silicon ball 21 whose diameter is a little less than 1mm at aluminium foil 22, as shown in drawing 5. A silicon ball is p mold, the surface layer 23 is diffused in n mold, and connection of a negative electrode is taken by pressing this fit in aluminum foil 22. Connection of a positive electrode ground the end for a non-light sensing portion of the above-mentioned silicon ball, exposed p field, and is realized by making the aluminum foil for the above-mentioned negative electrodes, and the aluminum foil 25 of one more sheet formed through the insulator layer 24 contact. Although such structure is rich in flexibility and the path is paved for continuation formation, the process which embeds a detailed silicon ball at aluminum foil was complicated, and there was a difficulty in manufacturing to a high speed and a large quantity.

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EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, the solar battery of comparatively high conversion efficiency can be continuously manufactured at a high speed using a cheap silicon ingredient. If it is the base constituted with a fiber if the meaning of this invention is followed, it will not be restricted to the configuration or its arrangement of yarn, and a textile-fabrics method.

[0040] Moreover, although the example has described the structure and the manufacture approach of a solar battery about the body of a solar battery based on the semi-conductor lump of p mold, it cannot be overemphasized by replacing the polarity of a conduction type also about a n-type-semiconductor lump that it can carry out similarly. Moreover, even if semi-conductors are the element semiconductor not only containing Si but germanium etc., a group III-V semiconductor, an II-VI group compound semiconductor, KARUKO pyrite compounds, or these conjugated compounds, they do not interfere.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By offering the new maintenance approach of a granular silicon cel, this invention enables continuous manufacture at high speed, and it is cheap and it aims at offering the solar cell module which was rich in application, and its production system.
[0007]

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MEANS

[Means for Solving the Problem] The above-mentioned technical problem improves substantially by holding the granular silicon which constitutes a solar battery element by the structure of the mesh who has arranged by turns the conductor of the amphipathy by which insulating separation was carried out mutually, as shown in the conceptual diagram of drawing 1.

[0008] The situation that the solar battery element (a cel is called below) is held is shown in drawing 6 in cross section. The granular silicon 31 which constitutes a cel is p mold, and n type layer 32 is formed in the front face. A cel is held so that it may be embedded at the mesh Mr. structure, and it is connected to each of the conductor of the amphipathy established there by at least one place. Usually, the conductor 33 connected to n type layer of a cel makes Ag a subject, the conductor 34 connected to p mold field of a cel makes Ag containing aluminum a subject, and p mold field and non-rectifying action connection are made by alloying in the connection 35 with granular silicon. the surface n type layer of a periphery is removed in a part for the connection to this p mold field -- having -- **** -- the connection with p mold field -- the connection with a conductor (the following and a positive electrode -- a conductor is called) and a surface n type layer -- electrical isolation with a conductor (the following and a negative electrode -- a conductor is called) is realized. each -- two or more cels are connected to the conductor at juxtaposition, and when light hits, the comprehensive output of a cel by which parallel connection was carried out is obtained from a conductor. a positive electrode -- a conductor 34 and a negative electrode -- the conductor 33 is arranged by turns and the output characteristics of the solar battery which constituted positive electrodes and negative electrodes by connecting with juxtaposition using the conventional plate mold substrate, and resemblance are obtained. moreover, forming the situation that single-tier formation of the cel is not carried out, or having left the conductor of a couple to the connectionless condition -- a positive electrode -- a conductor and a negative electrode -- it also becomes possible by connecting a conductor to a serial to take out the output of high tension. Therefore, it becomes possible to constitute the module of a desired unit at a stretch by preparing the mesh Mr. structure which prepared wiring of a serial parallel beforehand.

[0009] Since the structure which supports a cel is the mesh who has the opening which cannot pass a cel, it is drawing in compulsorily etc., and even if it does not treat a cel separately, a grain-like cel can be easily arranged in self align, it is making heating alloying perform simultaneously, and very high productivity is acquired. Although the cel supported by the mesh Mr. structure is weak against an impact if it remains as it is, carrying out a lamination with a resin film, or operating orthopedically, by carrying out a resin seal, rigidity can be given and it can form in a weatherproof **** module. These processes can be performed on continuation or a continuation target, realizing high productivity.

[0010]

[Embodiment of the Invention] Hereafter, this invention is explained in accordance with an example.

[0011] (Example 1) A cel is formed from granular silicon of 0.5-2ohms of p molds cm. The manufacture approach of granular silicon is outside the object of this invention, and does not make reference here. Although it is not cared about even if granular silicon is polycrystal, and it has single-crystal-ized it again, as for near and particle size, for applying this invention, it is desirable for a configuration to be [for the diffusion length of a minority carrier] more than particle size in 300 thru/or about 500 micrometers at an outline globular form. In this example, Czochralski crystal of 0.5ohms of p molds cm was cut down on 0.7mm square, and it is the mixture of fluoric acid and a nitric acid, and etched isotropic, and what was adjusted to the particle size of 500**50 micrometers was used.

[0012] n type layer was formed filling up with granular silicon the cylinder made from quartz glass which formed drawing in both sides, and making it rotate centering on a cylinder shaft. formation of n type layer -- nitrogen gas 0.5 l/min Oxygen gas 0.4 l/min a gaseous mixture -- POCl_3 -- a bubble -- carrying out

-- this and nitrogen gas 4 l/min the inside of the mixed ambient atmosphere -- 850 degrees C and 35min heat-treating -- after that and an ambient atmosphere -- oxygen gas 10 l/min changing -- further -- 5 min It carried out by heat-treating.

[0013] the inside of the desiccation oxygen gas ambient atmosphere after once removing the phosphorus glass formed in the front face of granular silicon by diluted fluoric acid and carrying out forcible washing by deionized water, and 800 degrees C and 60 min -- it oxidized. What was formed by this is the granular silicon cel 1 in drawing 1 .

[0014] On the other hand, the mesh Mr. structure (it is described as a glass fabric below) which supports a granular silicon cel was formed as follows. The basic structure is quartz glass fiber whose wire size is 25 micrometers, and used as warp (4 reference of drawing 1) what twisted seven of these. What twisted seven things which turned 0.1-micrometer coat of Ti to quartz glass fiber up, and carried out 2-micrometer coat of Ag was made into the 1st weft (3 reference of drawing 1). Moreover, what turned 0.1-micrometer coat of the aluminum to quartz glass fiber up, carried out 1.5-micrometer coat of Ag, and carried out 0.1-micrometer coat of Ag for aluminum 0.4 micrometers and on it further was made into the unit, and what twisted seven of these was made into the 2nd weft (2 reference of drawing 1). It wove to the flat cloth using these warp and 1st and 2nd weft. The pitch of yarn spacing is 0.5mm. The 1st weft was formed in the one direction of a flat cloth for a long time 10mm than the 2nd weft, and the 2nd weft was formed in the opposite direction of a flat cloth for a long time 10mm than the 1st weft. This is needed at the time of the ejection of a next photoelectrical output.

[0015] Immobilization of granular Si to a glass fabric used the revolution heating attraction drum unit as shown in drawing 7 . A glass fabric 41 is sent from a roll reservoir (not shown), it is twisted around the revolution attraction drum 42, and the glass fabric 48 with which the granular Si cel was fixed is sent to a reel (not shown). While the granular Si cel 43 is supplied to a rotating drum from the cel supply pipe 44, the glass fabric attracted by the revolution attraction drum is adsorbed. Although it is an ideal that each eye of a glass fabric is adsorbed in a granular Si cel, it does not interfere, even if there is a granular Si cel of the eye which remains without being able to adsorb actually, and the excess by which the gap of a granular Si cel where it adsorbed is adsorbed further. The granular Si cel of an excess is effectively removed by the blower 45, returns to a gutter 46, circulates further, and is supplied again. While the granular Si cel in which the eye of a glass fabric was adsorbed is heated on a fixed drum and being firmly pushed into a glass fabric eye, alloying takes place in part, and contact to the 1st weft and the surface n diffusion layer of a granular Si cel is acquired, and the non-rectifying contact according [the 2nd weft and p core of a granular Si cel] to aluminum alloying is formed. If forced oscillation, such as a supersonic wave, is desirably added at the time of this actuation, it is effective for acquiring firm and positive contact. As a result of this actuation, since it is canceled at subsequent processes even if it is in a short circuit condition, the 2nd weft and the surface n diffusion layer of a granular Si cel do not interfere. Whenever [stoving temperature / of the drum for immobilization] is 750 degrees C, and, as for the ambient temperature of the fixed process of a granular cel, it is effective to keep at 500 degrees C or more. In addition, drawing 7 is drawing showing the principle of a process, and is not what expressed the dimension of actual equipment faithfully.

[0016] In addition, it carries out to this process and coincidence by the approach of showing the connection for the parallel connection of granular Si in drawing 8 . Like the above-mentioned, from the weft of the others in the both sides of a glass fabric respectively, the weft is formed for a long time 10mm, and as it connects the weft of the same class, it connects an electrode lead. namely, a positive electrode -- the 2nd weft formed with a conductor 2 is connected mutually -- as -- the positive electrode lead 5 -- preparing -- a negative electrode -- the negative electrode lead 6 is established so that the 1st weft formed with a conductor 3 may be connected mutually. although there is especially no assignment in a connection method -- a tabular lead -- a lengthwise direction -- bending -- each -- the approach of sticking by pressure so that a conductor may be put was trustworthy. Although each electrode lead is used in the condition of having continued to serve both as the object for actuation or guide of a glass fabric, after separating into each submodule, as shown in drawing 8 , the end is respectively connected to terminal assemblies 7 and 8, and the output ejection to the exterior is presented with it, until a module is formed.

[0017] Although it returns to a process, being immersed in the cell with which the etching reagent was filled, and irradiating light, the glass fabric with which the granular Si cel was fixed is etched electrochemically, and performs a pn junction. The reason which irradiates light is for using the effectiveness that an etching reaction is accelerated in the exposed part of pn junction by work of a local battery. This processing is very effective in a short time, and each granular Si cel comes to commit it as an independent solar battery respectively through this process. Furthermore, to serve also as surface passivation, with the pyrolysis gaseous-phase vacuum deposition of the organometallic compound of Ti,

65nm of TiO₂ used as the antireflection film is formed, and modular basic structure is completed. [0018] Some approaches are possible in order to carry out a modularization. In order to consider as general module structure, the above-mentioned module basic structure is cut by suitable die length, the lamination of the whole is carried out across the table rear face of the above-mentioned basic structure with a bonnet, the consolidation white sheet glass of 4mm thickness, and aluminum lamination fluororesin film with a thickness of 125 micrometers with a still better known EVA film, and a terminal assembly is formed in an electrode lead, closing a periphery by installation and isobutylene isoprene rubber so that it may dedicate in a metal frame.

[0019] In the case of this invention, modular basic structure is a continuum and long module formation is possible for it, but all cels are not usually connected to juxtaposition and it is necessary practically by making magnitude of a certain extent into a unit to carry out a series connection. In the case of this invention, as shown in drawing 9 (A), the smallest unit of a cel is granular Si1, but the granular Si cel train connected in common by the 1st and 2nd weft is already mutually connected to juxtaposition, and the comprehensive output is taken out by the 1st and 2nd weft 2 and 3 extended to glass fabric both ends. The series connection of a granular Si cel column group of each leads 5 and 6 of the positive electrode which connects the weft, and a negative electrode becomes possible by dividing for every granular Si cel column group of suitable magnitude, and short-circuiting the negative-electrode lead 6 and the positive-electrode lead 5 in jumpering 9. Drawing expressed in the equal circuit using a diode notation is shown in drawing 9 (B). In the above-mentioned connection, since the output voltage of each granular Si cel train is about 0.5V, about 0.5 V is obtained also for the output voltage of a granular Si cel column group, and, as for the output current of a granular Si cel column group, the number twice of the output current of a granular Si cel are obtained. Therefore, near and the output current are equal to the value of a number of a granular Si cel column group of abbreviation 1/2 with which modular output voltage was connected to the serial to the output current of a unit granular Si cel column group. The module with a width of face [of 100mm] and a die length of 300mm was formed in 0.5mm pitch, the granular Si cel column group was constituted from an example for every die length of 25mm, and the meantime was connected to the serial. The open circuit voltage of the module in the optical exposure conditions of AM1.5 and 100 mW/cm² was 7.8V, the short-circuit current was 0.55A and conversion efficiency was 10.7%. [0020] What is necessary is for the jumpering which connects between forward negative-electrode leads as shown by drawing 9 to become unnecessary, and just to prepare the lead 9 and 9' which only tie two granular Si cel column groups by designing the value of an electrical-potential-difference current beforehand, and pulling out the 1st and the 2nd weft by turns for every granular Si cel column group, as shown in drawing 10 when the magnitude of the granular Si cel column group made into a unit is decided. After this connects a granular Si cel train with the lead of ends, in order to realize it by cutting a lead according to a granular Si cel column group, productivity becomes good more. In addition, although it is necessary to remove the granular Si cel column group of one to 2 train in order to carry out a series connection, the loss for it is 2 - 4% in the above-mentioned example. By the module furthermore optimized, the mask of a part of glass fabric part is carried out to the part which carries out a series connection, and a granular Si cel train is made not to be formed in it. Or in case a glass fabric is formed, inserting as the weft the glass fiber with which metallic coating is not performed for every unit of the supposing the granular Si cel column group of a unit can also realize separation of a granular Si cel column group.

[0021] A modularization is performed by including in protection material or maintenance material, after the above-mentioned connection is performed, but lightweight-izing is possible by inserting into transparent plastics other than the above-mentioned glass super straight structure, such as polymethylmethacrylate and a polycarbonate, and carrying out lamination molding, and if a mould is carried out also to a front flesh side with the glass of a low-melt point point, weatherability and fire retardancy will be improved. Although the white sheet consolidation plate glass 4mm or more adopted by the conventional glass super straight method is needed in order to secure the reinforcement as a module, it becomes fully securable [self-hold thru/or need reinforcement] also with an about 2mm thin module object by embossing formation of a corrugated plate or a three dimension as shown in drawing 11 or drawing 12 .

[0022] Drawing 11 (A) is the conceptual diagram of the module processed in the shape of a corrugated plate. Some [the / 50] cross sections are shown in drawing 11 (B). Many granular Si cels 1 are fixed and a module is formed by unifying on both sides of the glass fabric 48 by which connection was carried out by the table lamination material 51 and the flesh-side lamination material 52. Various things are used for a lamination ingredient according to applications, such as acrylic resin (PMMA etc.), a polycarbonate, polyethylene system resin (PET etc.), and styrene resin. As a table lamination ingredient, spreading or the thing which carried out the laminating is also used for the glass material processed in the shape of a corrugated plate in the resin for a buffer of EVA etc. The laminated film of shock absorbing material, such as EVA, and fluororesin may be used as a flesh-side lamination ingredient. These lamination material may

combine and use. Moreover, it is also desirable from a viewpoint of a deployment of light to carry out the laminating of films, such as aluminum with a high reflection factor, or the thin film to a flesh side. As for the approach of utilization, it is also arbitrary to also use a corrugated plate-like module independently and to reinforce by the frame and to use. Although there is especially no limit in the curvature of a corrugated plate, the curvature in which bending of a fiber cloth is possible is min, and although max serves as magnitude which can give modular rigidity, it is the range of about 3-20mm in radius of curvature desirably.

[0023] Drawing 12 (A) is the conceptual diagram which expressed visually the example processed in the shape of three-dimension embossing, and is the example cast in the shape of [which is expressed by $Z = \sin X + \cos Y$ to a height Z direction about the location within a module side (X, Y)] a curved surface. The cross section in alignment with the X-axis or a Y-axis is a configuration as shown in drawing 11 (B), and can raise flexural strength to every direction. This module should just also prepare a reinforcement frame on the outskirts if needed. Although there is especially no limit in the configuration of embossing, and a dimension, the consideration which mitigates the stress concerning module basic structure is required, and its configuration which changes smoothly with the curvature of about 3-20mm succeeding the direction of X-Y is desirable like the case of the corrugated plate of drawing 11 .

[0024] If the above-mentioned module structure is possible, it closes manufacture by the continuous process as shown in drawing 13 . In addition, drawing 13 shows the configuration of a process typically and refuses beforehand that it is not faithful to a actual configuration.

[0025] A glass fabric as shown in drawing 13 (A) from the supply reel 61 is supplied. A glass fabric uses glass fiber as warp, it carries out a plain weave by the weft which allotted by turns the 1st weft which twisted glass and Ag coat line, and the 2nd weft which twisted glass and aluminum, and Ag coat line, and it is beforehand formed in the shape of a roll at another process.

[0026] A hopper is loaded with granular Si62 adjusted to the particle size of 0.5mm, and 1-2ohms of p molds cm, it is suitably supplied to the belt 63 for diffusion, and is sent to a diffusion furnace 64. It is heated in POCl_3 ambient atmosphere here, and n+ layer is formed in a front face. Granular Si by which n+ layer was formed in the front face is once stored in another hopper 65, and is supplied to the glass fabric sent from the supply reel 61. The condition that each eye of a glass fabric was loaded with granular Si by the blow controlled [which were controlled and was enforcement-attracted] as shown in drawing 13 (B) is made from this process. By passing through a heating furnace 66, where granular Si is temporarily fixed to a glass fabric, alloy fixing with the electrode metal and granular Si which were taught to the warp of a glass fabric takes place, and, as for the 1st weft, p nucleus part of granular Si and electric contact are acquired through p+ recrystallized layer in this phase, as for n+ mold surface layer and the 2nd weft. In this phase, the 2nd weft forms contact with an electric surface n+ layer, and the junction as a solar battery is not separated. Subsequently, the antireflection film of TiO_2 is formed in the CVD furnace 67 for this by oxidation of tetra-propoxy-titanate in delivery and atmospheric pressure. Under the present circumstances, although heterogeneity arises in thickness with the irregularity of a covering substrate and it is formed in the thickness of acid-resisting conditions on a front face, near the point of contact with a glass fabric, it hardly covers.

[0027] the etching tub 68 with which this was filled up into lye -- delivery and the thin granular Si part of the antireflection film -- **** -- it etches thinly. At this time, a part for the joint of p mold and n mold is early etched more by work of the local battery produced by optical exposure, and, thereby, junction isolation of pn is performed. That is, as shown in drawing 13 (C), the 2nd weft forms the field of p mold, and electric contact, and it becomes possible to take out the output of the positive/negative of a solar battery from each weft.

[0028] The glass fabric which ended junction isolation is cast by tabular module foundation structure as passed along a cleaning tank 69, impregnation carried out by the resin supplied from the organic resin feeder 70, and curing carried out with a heating furnace 71 and shown in drawing 13 (D), and is rolled round by the machine reel 72.

[0029] Just before carrying out curing with a heating furnace 71 for processing it a corrugated plate or in the shape of embossing, configuration molding is performed to the midst, and it is cut and accumulated by the die length suitable in this case for a volume and ****.

[0030] As compared with module formation of the conventional shape of a substrate Si, module formation is possible for this production process at a continuation part, and as long as there is no limit in the width of face of a glass fabric and equipment allows by adopting a granular cel, module formation is possible for it also by the width of face which is several m. Moreover, although it rolled round to the reel and the possibility of the continuation formation by batch processing of a roll two roll was shown by this example, consistent integration of all processes is also possible by continuation-izing from the formation process of glass fiber. Therefore, by application of this invention, the production process which was extremely rich in

mass production nature can be built.

[0031] (Example 2) Drawing 14 is the perspective drawing which looked at the maintenance situation of a granular Si cel with a diameter [by the glass fabric which used the fiber with a diameter of 25 micrometers as 7 twist plain weave] of 500 micrometers from the weft. Although the pitch of a fiber is the same 500 micrometers as the diameter of the granular Si cel 1, the overall diameter of a fiber is 75 micrometers, and a granular Si cel is held by the glass fabric, without passing texture, even if there is a maximum of 75-micrometer particle-size fluctuation, the case where particle size is 500 micrometers -- a positive electrode -- a conductor 2 and a negative electrode -- the weft and the granular Si cel 1 by the conductor 3 touch in one fourth of the height of a diameter mostly, and two points of contact are obtained about each conductor at a time. The radius of curvature of glass fiber support can form a plain-weave-like glass fabric without those of a path with 30 times, and unreasonableness by about 750 micrometers. Increasing the number of stranded wires does not bar using glass fiber thinner than this. Although reinforcement becomes weak a little, it is effective in raising the yield of a poor contact that the number of points of contact with a granular Si cel increases. However, if many [too], a necessary metallic material will increase and it will become rather uneconomical.

[0032] Drawing 15 is the metallic conductor supported by glass fiber and drawing showing a contact situation with a granular Si cel. Coating of the 0.1-micrometer aluminum layer (in drawing, it does not show clearly) is carried out to fiber glass 81 on a front face, and the Ag layer 82 with a thickness of 1.5 micrometers and the aluminum layer 83 which is 0.5 micrometers in thickness further are formed in up [the]. A metal layer deforms into extent which touches fiber glass 81 in the phase where the granular Si cel 1 was held. aluminum layer near the point of contact and the surface layer of granular Si alloy at the process of alloy-izing, and p+ layer which is mostly equivalent to the thickness of aluminum layer is formed in Si nucleus side of an alloy layer 84. The output of a cel 1 is transmitted to a metal layer through this.

[0033] For the object which realizes contact to p mold field, the coat of the high conductivity metals which contain III group elements used here, such as Ga besides aluminum and In, in the form of a simple substance or an alloy, such as Ag and Cu, may be carried out to glass fiber, or a thin line may be twisted. In order to realize contact to n mold field similarly, under the controlled conditions besides Ag or the high conductivity metal of Cu, the activity of aluminum is also possible, and it is more effective in the former that V group elements, such as P, As, and Sb, are included.

[0034] Although twisting both glass fiber is also considered, as metaled single track is shown in drawing 14 as a fiber, the opportunities of contact to granular Si are few, and in order to make it contact certainly, it can be understood that the structure where the metal was supported by each glass fiber is desirable. moreover, the case of single track -- the process of alloy-izing -- alloying -- self -- a restrictive device does not work, but there are a danger of forming a deep alloy layer in granular Si, and danger of an open circuit of a metal wire, and the structure where the metal was supported by glass fiber is desirable too.

[0035] Drawing 16 shows other examples of this invention about maintenance of a granular Si cel. as the weft combined with the warp 4 which is what replaced with the glass fabric of the shape of a plain weave shown in drawing 1, and was formed in the shape of *****, and consists of glass fiber -- a positive electrode -- a conductor 2 and a negative electrode -- in addition to the 2nd and 1st weft which consists of conductors 3, 3rd weft 4' which consists of glass fiber is allotted. also in this case, a positive electrode -- a conductor 2 and a negative electrode -- a conductor 3 is arranged in parallel to alternation, and it has structure separated by the insulator so that it may not connect too hastily mutually. In this example, by arranging a spherical Si cel by minute restoration, the filling factor (projected area) of a cel becomes 91%, and can improve a filling factor about 15% compared with the case of a plain weave. In the case of a non-condensing module, this can become with an improvement of an output, and can raise module reinforcement. About the approach of the connection about the limitation of the die length about the ejection of a conductor, and the series connection of a submodule, it is applicable like the case of a plain weave.

[0036] (Example 3) When a generation of electrical energy is presented with the module formed with the application of this invention, it can consider as the module excellent in workability with devising connection beforehand. Drawing 17 (A) has illustrated the situation in the case of forming a roof for many corrugated plate-like modules in piles. Although the example which fixed the corrugated plate module 91 of two sheets to sarking 92 in piles is shown here, the cross section of the situation is shown in drawing 17 (B). Although the fixed portion 93 pierced through the module of two sheets and has concluded it with the bolt, for making this possible, it is necessary to form a breakthrough 94 in a module. Although a submodule generally is not arranged around a breakthrough 94, when a module is linearly formed like the manufacture example of this invention in that case, a big useless area equivalent to the width of face of the submodule of a unit will be produced. Then, even when the field 96 which does not support a metal beforehand is

established in a part of glass fiber group 97 which supported the metal about the part of that schedule area 96 when the location in which a breakthrough 95 is formed like drawing 17 (C) was able to assume beforehand and a granular Si cel is temporarily fixed to this part, it is advantageous on a process to fix positively the poor opening condition which does not contribute to a generation of electrical energy. A module can be manufactured that what is necessary is just to carry out the plain weave of the glass fabric at the same process as usual between the glass fiber groups 98 used as warp, without barring other production processes. When it becomes the schedule field processible [which digs a breakthrough mechanically] and a module can be more simply formed in it after a modularization is carried out if it does in this way, construction becomes easy, therefore solar-battery array cost can be reduced.

[0037] (Example 4) Other examples of this invention are shown in drawing 18 . a positive electrode -- a conductor 2 and a negative electrode -- a conductor 3 is made into the weft and a granular Si cel serves as reverse juxtaposition in the direction of warp in the glass fabric of the plain weave which has arranged this by turns. the positive electrode which adjoins each other mutually at the edge of the weft here if the granular Si cel 1 can be located in a line every other train like drawing 18 (A) -- a conductor 2 and a negative electrode -- a series connection becomes possible by making a granular Si cel train into a unit by connecting a conductor 3. The equal circuit is shown in drawing 18 (B). A number of a granular Si cel train of more than electrical potential differences of V which are equivalent to 2 about 1/by which the series connection was carried out are obtained from output terminals 7 and 8. In the case of the module which consists of glass fabrics of granular Si with a diameter of 500 micrometers and 500-micrometer pitch, the output of 100V will be obtained every 10cm. the positive electrode which uses glass fiber 4 as warp and serves as the weft as it is shown in drawing 18 (C), in order to put a granular Si cel train in order every other train -- a conductor -- the weft 2 and a negative electrode -- a conductor -- the weft 3 -- in addition -- for example, what is necessary is just to interfere so that granular Si cel 1' may not be fixed by the 3rd weft 400 which consists of glass fiber Such a configuration is possible by the well-known textile-fabrics method.

[0038] (Example 5) Other examples of this invention are shown in drawing 19 . This is an example which made it the number of the eyes of the glass fabric of a plain weave, and has arranged the granular Si cel every every direction 2 eye. This is an example by which granular Si cel 1' has been arranged at the core of a 9 times as many field as own magnitude. this -- the three weft of a plain weave -- a unit -- carrying out -- a positive electrode -- a conductor 2 and a negative electrode -- it is arranged, and obstructive yarn 400 is inserted in the train in which a granular Si train is not formed in addition by 2 continuation, and it is formed so that each warp of a conductor 3 and a nonconductor 200 may be repeated. Moreover, obstructive yarn 401 is formed in 2 continuation about the nonconductor yarn 4 which forms a plain weave also about warp, and the train to which a granular Si cel is not fixed. Such a configuration is also easily possible with a well-known textile-fabrics technique. The solar cell module with which the granular Si cel has been arranged by the production process shown in the example 1 when preparing such a glass fabric so that it may illustrate can be formed. By applying to the module which equipped each granular Si cel with the condenser lens, such a configuration can reduce the amount of the semi-conductor used in the same light-receiving area a figure single [about], using the same process, and can offer the solar battery of low cost.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The mimetic diagram for explaining the configuration of this invention.

[Drawing 2] The bird's-eye view explanatory view of the conventional solar battery element structure.

[Drawing 3] The bird's-eye view showing the connection concept of the conventional solar battery element.

[Drawing 4] The cross-section block diagram of the conventional solar cell module.

[Drawing 5] The configuration sectional view of the conventional spherical silicon solar cell.

[Drawing 6] The cross-section block diagram of the granular silicon solar cell of this invention.

[Drawing 7] The conceptual mimetic diagram of the cel fixed process in the production process of the module which applied this invention.

[Drawing 8] The mimetic diagram showing the example of connection of electrode wiring in the module which applied this invention.

[Drawing 9] The explanatory view showing the example of a series connection in the module which applied this invention.

[Drawing 10] The explanatory view showing other examples of a series connection in the module which applied this invention.

[Drawing 11] The bird's-eye view and cross-section structural drawing showing the configuration of the corrugated plate-like module which applied this invention.

[Drawing 12] The bird's-eye view image conceptual diagram of the letter module of three-dimension embossing which applied this invention.

[Drawing 13] The elevation surface conceptual diagram of the module consistent manufacture process which applied this invention.

[Drawing 14] The elevation surface mimetic diagram showing the relation of the cel and base in the module which applied this invention.

[Drawing 15] The cross section showing the connection of the cel and base in the module which applied this invention.

[Drawing 16] The flat-surface conceptual diagram showing one example of the wiring configuration which applied this invention.

[Drawing 17] The explanatory view showing other one example of the wiring configuration in the module which applied this invention.

[Drawing 18] The explanatory view showing other examples of wiring connection in the module which applied this invention.

[Drawing 19] The explanatory view showing other examples of wiring connection in the module which applied this invention.

[Description of Notations]

1 .. a granular Si cel and 2 .. a positive electrode -- a conductor and 3 .. a negative electrode -- a conductor and 4 .. insulating support (glass fiber) -- 5 5' .. A positive-electrode connection lead, 6, 6' .. A negative-electrode connection lead, 7 .. Positive-electrode terminal, 8 [.. Light-receiving side electrode,] .. A negative-electrode terminal, 11 .. A p mold Si substrate, 12 .. n mold diffusion layer, 13 14 .. A rear-face electrode, 15 .. The conventional solar battery element, 16 .. The conventional connection lead, 17 .. The tempered glass plate of the conventional module, 18 .. Conventionally A modular moisture-proof film, 19 .. The closure resin of the conventional module, 21 .. Conventionally The p mold Si ball of a component, 22 .. The aluminum foil of the conventional component, 23 .. n mold diffusion layer of the conventional component, 31 .. p mold granular Si, 32 .. n mold diffusion layer and 33 .. a negative electrode -- a conductor and 34 .. a positive electrode -- a conductor and 35 .. p mold

alloying field -- 36 [.. Granular Si cel,] .. Closure resin, 41 .. A glass fabric, 42 .. An attraction drum, 43 44 [.. A fixed drum, 48 / .. A glass fabric with a granular Si cel, 50 / .. A module, 51 / .. Table lamination material, 52 / .. Flesh-side lamination material.] .. A cel supply pipe, 45 .. A blower, 46 .. A gutter, 47

[Translation done.]

* NOTICES *

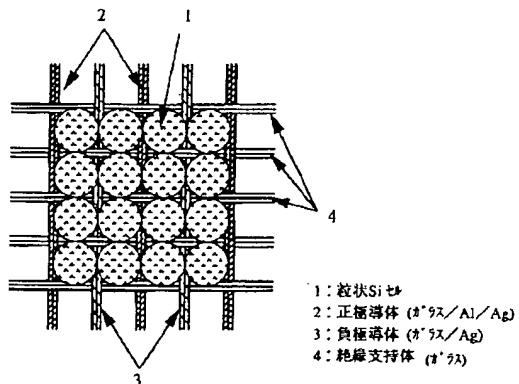
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DRAWINGS

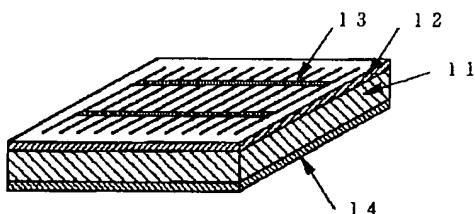
[Drawing 1]

図1



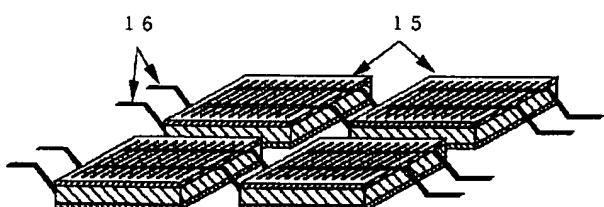
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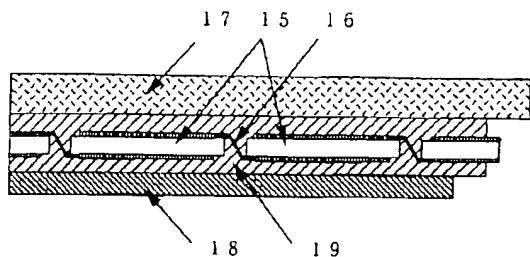
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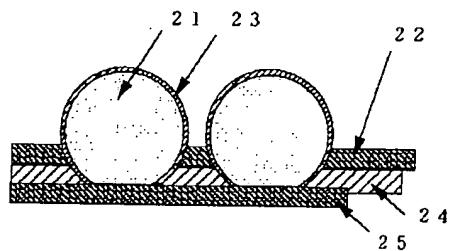
[Drawing 3]

図3

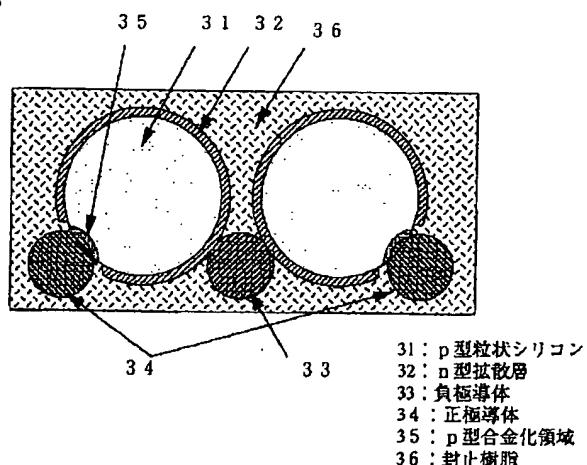


[Drawing 4]
図4

15: 太陽電池素子
16: 接続リード
17: 強化ガラス
18: 耐湿フィルム
19: 封止樹脂

[Drawing 5]
図5

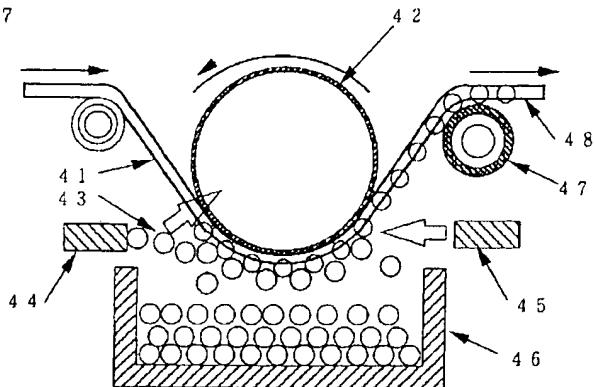
21: p型シリコン球
22: アルミ箔 (負極)
23: n型拡散層
24: 絶縁樹脂
25: アルミ箔 (正極)

[Drawing 6]
図6

31: p型粒状シリコン
32: n型拡散層
33: 負極導体
34: 正極導体
35: p型合金化領域
36: 封止樹脂

[Drawing 7]

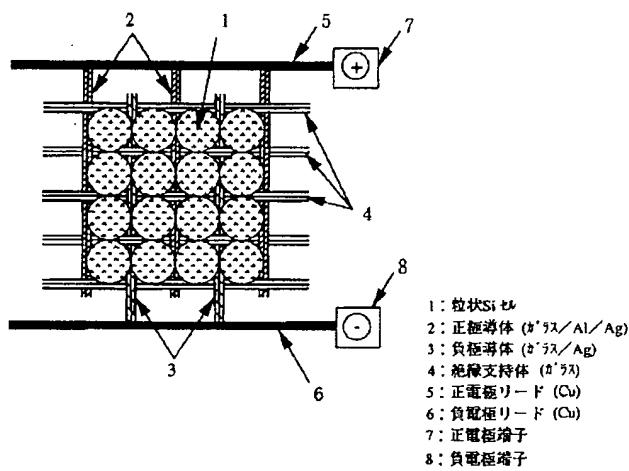
図7



41: ガラス布
 42: 吸引ドラム
 43: 粒状Siセル
 44: セル供給管
 45: プロワー
 46: ガター
 47: 固定ドラム
 48: 粒状Siセル付ガラス布

[Drawing 8]

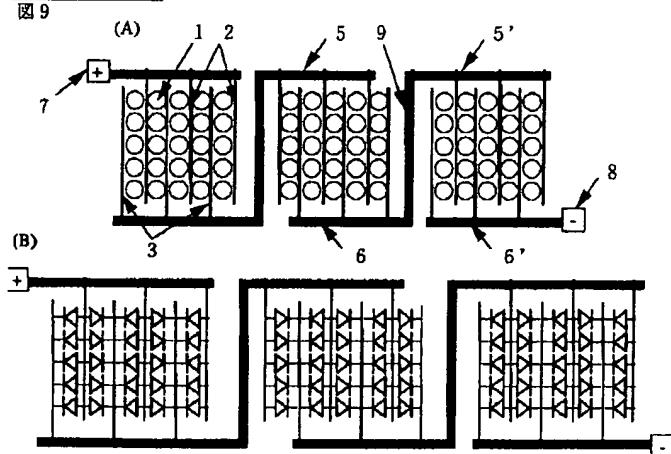
図8



1: 粒状Siセル
 2: 正電極導体 (ガラス/Al/Ag)
 3: 負電極導体 (ガラス/Ag)
 4: 绝縁支持体 (ガラス)
 5: 正電極リード (Cu)
 6: 負電極リード (Cu)
 7: 正電極端子
 8: 負電極端子

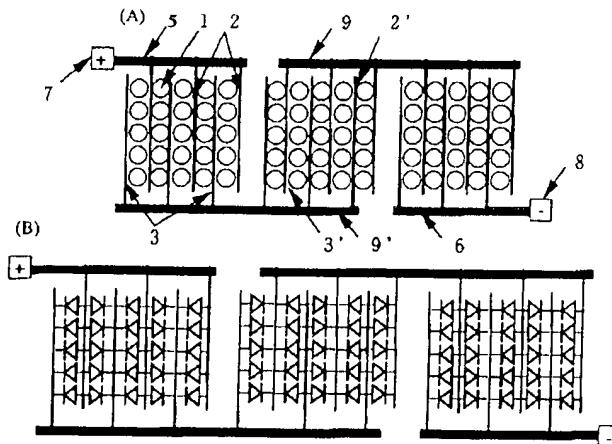
[Drawing 9]

図9



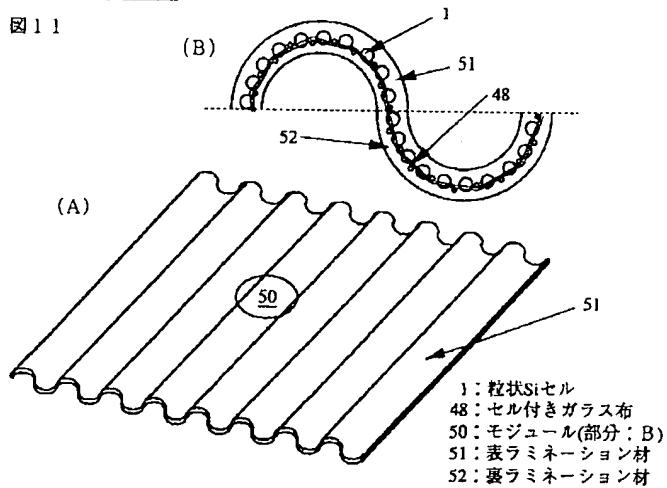
[Drawing 10]

図10



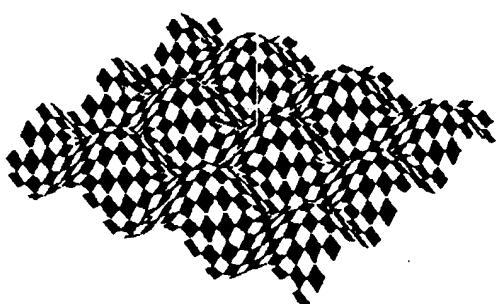
[Drawing 11]

図11



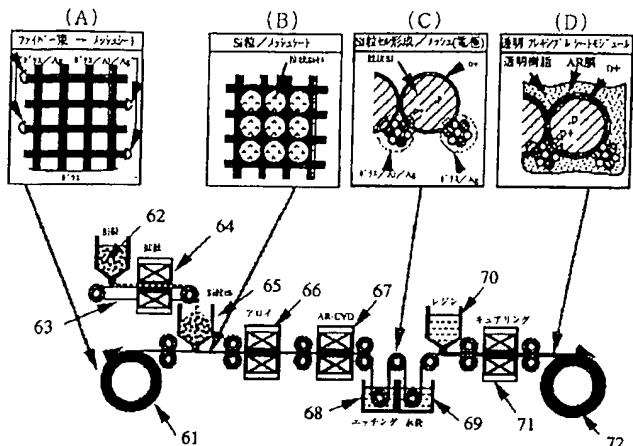
[Drawing 12]

図12



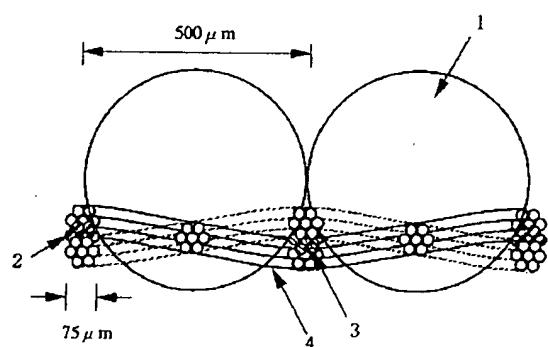
[Drawing 13]

図 1 3



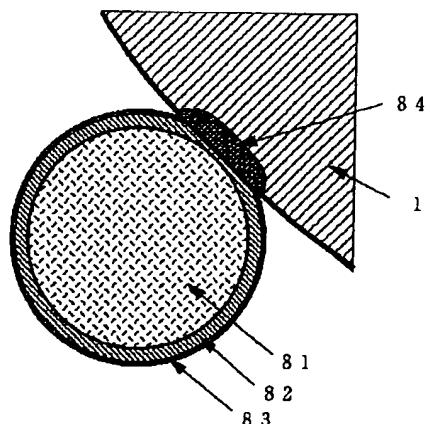
[Drawing 14]

図 1 4

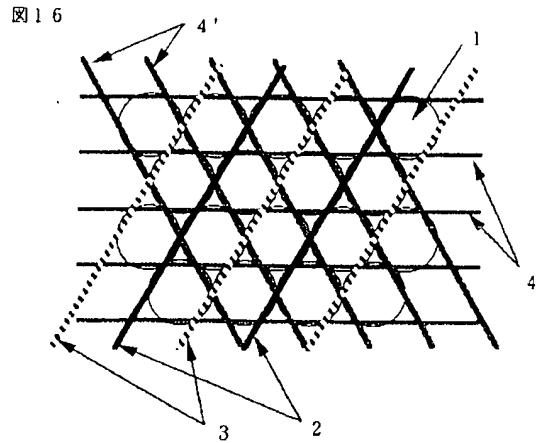


[Drawing 15]

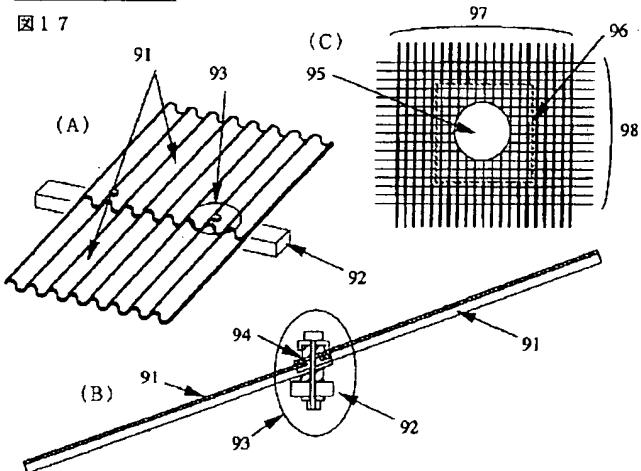
図 1 5



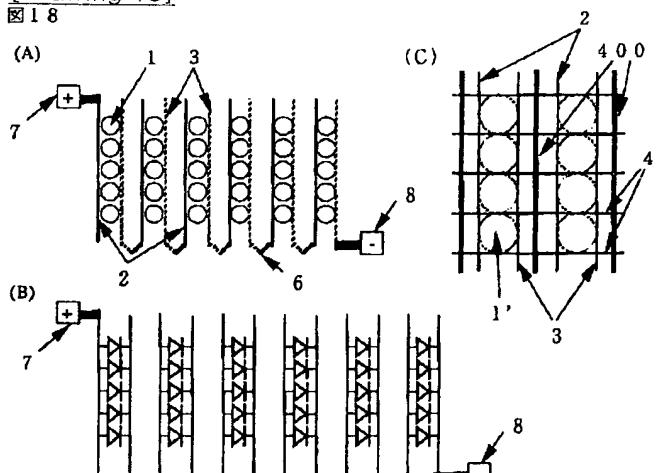
[Drawing 16]



[Drawing 17]

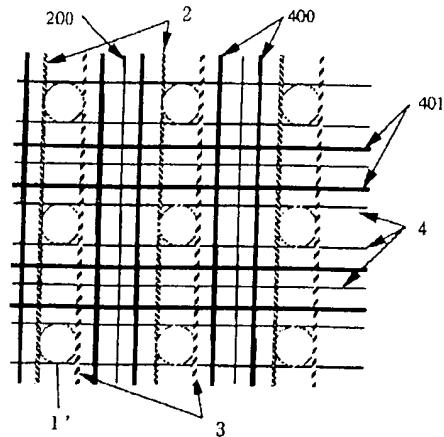


[Drawing 18]



[Drawing 19]

図 1.9



[Translation done.]